



St. Patrick's Teaching College, Drumcondra  
A College of Dublin City University

## **Western Seaboard Science Project**

**Development of Science in small disadvantaged rural schools in Counties  
Galway, Mayo and Donegal.**



**2008—2010**

**Final Report**

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## **Acknowledgements**

This project was possible due to the generous funding of the  
Irish American Partnership (IAP)

and

The Department of Education and Science (DES)

(now The Department of Education and Skills)

## **Background:**

The Irish American Partnership (IAP) has played a significant part in the development of science in disadvantaged small rural primary schools in Ireland. In 2003, a project to enhance the teaching and learning of science in 10 primary schools commenced in south Kerry. The project was made feasible by generous funding from IAP. The positive results from this project led to the expansion of the programme to 15 schools and an extension of the programme for a further three years. The value of the programme was recognised by the Department of Education and Science (DES), and it agreed to support the work of IAP. The programme in Kerry culminated in the award, in 2008, of Certificates in Education (Primary Science) to six participating teachers. The funding also enabled three of these teachers to embark on a Diploma in Education, (Primary Science). Their dissertations were submitted in May 2010 and the three teachers will graduate in November 2010.

The significance of these developments is immense. Having a cohort of teachers that has an in-depth knowledge of science education and is confident in their ability to teach science is of tremendous importance especially in rural areas. These teachers will be in a position to become peer mentors for their colleagues in both their own schools and in other schools in the locality.

## **Developing Science in rural primary schools in Ireland.**

Following the success of the Kerry science project, the IAP (and the DES) suggested providing a similar programme to schools in other disadvantaged areas. Fifteen small rural schools in Counties Galway, Mayo and Donegal were selected for the programme, which was designated the Western Seaboard Science Project (WSSP). The programme was directed by Dr Paula Kilfeather, Head of Biology Dept., St Patrick's College, Drumcondra and has been operating since 2008. The schools have benefited enormously from the generous funding which has enabled them to purchase equipment, so essential to the teaching and learning of science. Of even greater importance, the funding has enabled the appointment of a facilitator, Mr Greg Smith. Mr Smith put in place a comprehensive science education programme for the fifteen schools.

## **Funding**

The projected cost of the programme had to take into account travel to the fifteen individual schools, provision of equipment for each of the schools and the maintenance of the facilitator. Given the isolated nature of many of the schools, it was considered that eLearning training

and development was also essential. In addition each of the schools also received a grant of €3,000 to assist with visits to sites of scientific interest and the purchase of scientific books and equipment. The initial funding sought was €132,000 per annum, of which €66,000 came from the IAP and €66,000 from the DES.

The global financial downturn has resulted, inevitably, in a curtailment of funding and the project is now being wound down. Nevertheless the generous initial funding has enabled very useful work to be carried out and has resulted in enormous benefits to the participating schools, teachers and pupils.

### **Rationale for professional development**

The research literature regularly confirms that teachers are a key influence on whether students develop positive or negative attitudes towards science, especially in primary school when children have their first formal science experiences. It can be seen from the international research literature (e.g., Appleton, 2003; Goodrum et al. 2001; Harlen & Holroyd, 1997; Summers & Kruger, 1992) that primary teachers' confidence, competence and attitudes towards teaching science is a world- wide, not just an Irish, concern.

The past decade has seen major changes in science education in Ireland. A major reform, in the provision of science at primary level occurred with the introduction of the revised Primary School Curriculum (PSC) in 1999 (DES, 1999). However, concerns quickly emerged in a number of areas, namely: teacher confidence and competence in teaching science and also teachers' attitudes to teaching science. In 2008, the NCCA carried out a review of the primary science curriculum (Varley et al, 2008). This review highlighted a number of areas regarding the teaching of science, including poor teacher confidence when teaching certain concepts and skills in science. One of the main recommendations put forward in the review was the provision of ongoing comprehensive continuing professional development for teachers.

The literature on how to improve the teaching of science focuses in particular on two areas (a) support for teachers, in the form of professional development and (b) improving teacher confidence and competence (i.e. improving teachers' knowledge of science). This also includes developing positive attitudes towards teaching science.

Traditionally professional development in Irish schools focused primarily on the area of curriculum change, usually when a new curriculum is being introduced. This 'in-service' tends to be in the form of 'one off' and 'one-size-fits all' workshops where experts 'transmit' knowledge to teachers. The shortcomings of this traditional in-service training are well recognized and documented (Little, 1994). Examples of deficiencies cited by Little include: it is too fragmented, unproductive, inefficient, unrelated to practice, and lacking in intensity and follow up. Riding (2001) states traditional in-service sessions "generally prove to be ineffective in changing teachers' practice and have little, if any, effect back in the classroom".

Current literature on professional development advocates a move away from the isolated in-service workshops towards professional development that is ongoing and gives teachers opportunities to: collaborate with their peers sharing practices and knowledge, reflect on their pedagogic practice, focus on student learning, and be involved in decision making. (Kennedy 1998; Supovitz & Turner 2000; Hogan et al 2007). WSSP built upon current international thinking on professional development. Guided by the findings of the international research literature, the study explored new possibilities for teachers' professional development: in particular it focussed on the enhancement of teaching and learning science in fifteen small rural primary schools (two/three teacher schools).

Historically small rural schools are underserved by their isolation from (a) other teachers - the size of the school may mean that there are only one or two colleagues with whom to exchange ideas and advice, unlike the situation in a large school, where there are more colleagues, and (b) research institutions - teachers in small rural schools are often a long way from professional development provision in colleges and Education Centres. Due to this isolation, teachers in rural areas are often out of touch with optimal teaching strategies because they are not able to keep abreast of the most current research. WSSP hoped to break down this professional isolation.

### **Aims of WSSP**

1. To develop a model of professional development in science education with primary teachers in 15 small rural schools, in order to enhance the teaching and learning of primary science;
2. To investigate the extent to which this model can help bring about improvements in confidence, competence, attitudes and levels of knowledge among primary teachers where the teaching of science is concerned;
3. To investigate the extent to which students' attitudes are influenced by similar changes in teachers;

4. To break down the insulation and isolation that teachers experience in their day-to-day professional lives by developing *meaningful* collaboration using a workshop model, a Virtual Learning Environment and individual school visits;
5. To develop sustainable ‘learning communities’ both within and between participating schools.
6. To investigate what features of this model could be incorporated into continuous professional development for primary teachers more widely.

WSSP provided opportunities for the participating primary teachers to develop:

- A collaborative professional culture, in contrast to the traditional culture of isolation and insulation;
- Regular links with teaching colleagues in other schools;
- Greater pedagogical expertise and deeper subject knowledge;
- The skill of reflective practice in a supportive and safe environment.

One of the key aims of the project was to redress the insulation and isolation that teachers, particularly in rural areas, can experience in their day-to-day professional lives. Through developing a culture of *meaningful* collaboration (discussing classroom practice as well as sharing resources and ideas) WSSP hoped to break down professional isolation.

Developing a culture of meaningful collaboration involved:

- Building up of trust between the teachers, as a group, and the project facilitator;
- The project facilitator working closely with the teachers;
- Looking at ‘real’ issues and the needs of teachers in the day-to-day reality of their classroom;
- Deepening teachers’ subject and pedagogical knowledge in science;
- Teachers being the decision makers – encouraging them to believe in the relevance and importance of what they are engaged in.

### **The Intervention Model**

The professional development programme developed for WSSP differs in significant ways from the more traditional in-service models used in the Irish educational system. The WSSP programme provides an alternative to current practice. Defining features of the WSSP programme included an emphasis on:

**Active participation** – from the start workshops were of an interactive nature, with lecture-style presentations being kept to the minimum. They were designed and convened by the

facilitator, in on-going consultation with the participants. The process, while facilitated by the facilitator, was largely in the hands of the participants.

**Meaningful Collaboration** – As trust was built up between the teachers as a group and the facilitator, participants shared their expertise and perspectives on teaching and learning processes based on their experience within their schools and classrooms. This was encouraged and facilitated using various strategies such as: sharing resources and ideas; discussing pedagogic practice, and; using a password protected virtual learning environment; “Moodle”.

**Continuity** – The programme was designed as scheduled events within a developmental sequence (over 2 years) as distinct from being “once-off” events carried out at periodic intervals. This allowed the workshops to be designed as scheduled events within a developmental sequence.

**Feedback** – The programme included: (a) feedback (evaluation) to the facilitator after each workshop (b) feedback (progress reports) by participants to workshop participants during the workshop. This dealt with teaching and learning initiatives being undertaken by them in their own schools, and (c) feedback (evaluation) to the facilitator mid way through and at the end of the programme.

### **WSSP Workshops**

The Western Seaboard Science Project consisted of eleven 3 hour workshops held in and out of school time over a two-year period (October 2008 to May 2010). The workshops were designed and convened by the researcher, in on-going consultation with the participants. The facilitator also provided ongoing support for teachers in-between workshops. This support was in the form of Virtual Learning Environment (Moodle), e-mails, telephone conversations and visits to individual teachers in their schools (when requested). During these visits the facilitator demonstrated activities to students while teachers observed. He also observed teachers as they introduced workshop activities to their students.

The workshops were:

- Interactive in nature – teachers were involved in the design of the workshops and content presented at workshops. The reason for this was that teachers need to see the relevance of the content to their daily working practice (see figure 1 below);
- Collaborative in nature - teachers were encouraged to actively share resources and ideas and discuss pedagogic practice with colleagues from their own school and other schools (see figure 2 below).
- Teachers were encouraged to carry out action research in their classroom and discuss their findings with colleagues at the next workshop (encouraging teachers to become more reflective of their pedagogic practice).



- On-going, planned and developmental events as distinct from being 'one-off' events

**Figure 1: Interactive workshop**



Workshop content varied from workshop to workshop in response to teachers' stated needs, and included some or all of the following elements:

- Teacher engagement in a number of hands-on science activities;
- Teacher reflecting on their own science knowledge raised in the context of children's ideas;
- Introduction of innovative teaching methodologies;
- Teacher feedback on science tasks carried out with their students in between workshops;
- Teacher discussions, relating to their experience of teaching science, formed an important aspect of the workshops;
- Use of ICT in the classroom and introduction to Virtual Learning Environments – Moodle.

**Figure 2: meaningful collaboration**



### **Example of typical Workshop**

In our first round of workshops in September/October 2008 we decided to focus on electricity. Electricity was selected as all the teachers were introduced to this topic during their in-service (curriculum days). As a result, they all had some familiarity with electricity. The teachers were introduced to electricity under two main headings; (1) subject knowledge and (2) pedagogical knowledge (various teaching approaches).

#### Actual Workshop

- Discussion regarding; subject knowledge needed by teachers to successfully teach electricity and the misconceptions teachers and students may have regarding electricity;
- Teachers were introduced to two innovative teaching approaches in science education - Concept Cartoons and Predict-Observe-Explain (POE);
- Teachers carried out a number of electricity ‘hands on’ investigations;
- Teachers were given access to a number of resources using the Virtual Learning Environment – Moodle;
- Teachers were encouraged to carry out tasks with their students before the next workshop (e.g. introduce the students to Concept Cartoons and/or introduce their students to POE through investigations).

#### **Other Events**

- The facilitator was invited to all of the participating schools. In some schools he led the lessons; in others he acted as an observer with the teacher leading the lesson and asking him for a constructive critique after the lesson. This was encouraging as it showed that a build up of trust and openness had developed;
- A scientist from REMEDI Ireland (Regenerative Medical Institute) visited the schools. He introduced children to their body parts e.g. cells and DNA, and the importance of micro-organisms to our world;
- Schools, in the three different regions, came together in clusters in order to take part in the STEPS (Science, Technology, and Engineering Programme for Schools) challenge in March 2009.
- Astronomy Ireland visited all three clusters of schools. They set up a planetarium in the schools, and introduced children to different aspects of the universe.
- A number of schools visited science exhibits/museums and farms.
- Clustering of schools meant that different speakers, trips etc. were organised on a cluster level instead of individual school level. Thus, schools could cut down on costs and develop professional and social communities between their schools.

## **2010**

Mr Greg Smith presented a paper, outlining the project, at the Irish Association for Social, Scientific and Environmental Education (IASSEE) conference in Belfast.

An article about the project was prepared by Mr Smith and will be published in the Irish National Teachers Organisation (INTO) magazine. This magazine is distributed to all primary schools in Ireland.

Mr Greg Smith will be presenting two further papers about the project in the near future. The first will be at the Church of Ireland College of Education (CICE) conference in September 2010. The second will be to the National Academy for Integration of Research, Teaching and Learning (NAIRTL).

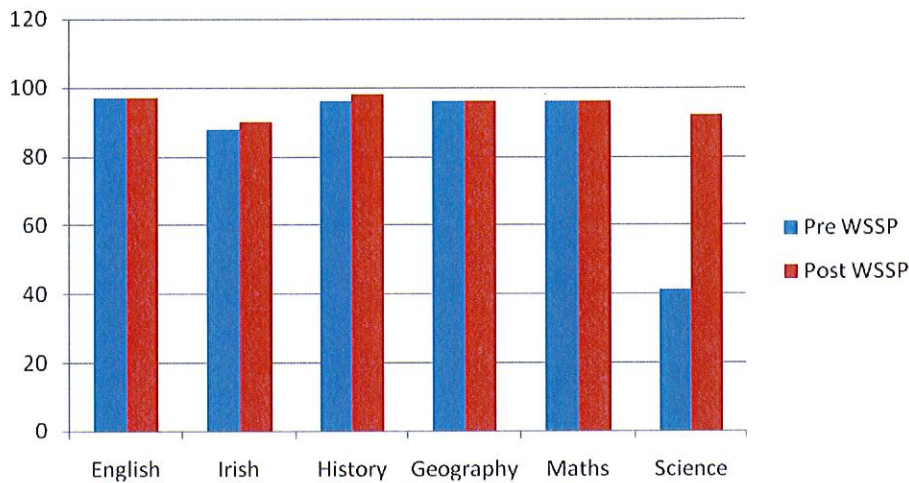
### **Outcomes.**

#### *Teacher confidence across seven subject areas*

Prior to their involvement with WSSP, teachers were less confident about teaching science than teaching English, Irish, history, mathematics and geography. This is similar to findings by Harlen (1995). In 1995, Wynne Harlen published her influential study on primary teacher confidence in teaching science in Scottish schools. She reported then that teachers were less

confident teaching science than most other subjects on the curriculum. When asked to rate their confidence in teaching 11 subjects, Scottish teachers ranked science in eighth place. Post WSSP intervention, science confidence in the Irish teachers improved significantly and no longer differed from confidence in teaching of other subjects (see Figure 3). This result indicates that the intervention programme had a positive influence on teacher confidence in science teaching.

**Figure 3 Changes in teachers' confidence across six subject areas (before and after instruction)**



These results are also similar to findings by Murphy et al (2007). Murphy cited professional development as the most important factor influencing confidence in primary science teaching “Confidence was significantly higher if teachers had carried out some professional development in primary science”. (p. 424).

#### *Teacher confidence teaching content of science curriculum*

The content of the primary science curriculum is divided into four strands: *living things*, *energy and forces*, *materials and environmental awareness and care* (DES 1999). Primary teachers are expected to cover all four strands regardless of their level of interest or qualification in science.

Prior to WSSP, teachers in general were very confident about teaching *living things* and *environmental awareness and care*. They were reasonably confident teaching about *materials*. However, teachers had low levels of confidence teaching about *energy and forces*. In the main, teachers' perceived confidence in physical science items was lower than in

biological science items. Teachers had difficulty with a number of the more conceptually challenging physical science topics, such as: how sound travels and how it is produced, the splitting of light and mixing colours and how we see things, the force of gravity, and electrical energy. These results are consistent with those of Harlen et al. (1995) and Murphy et al. (2007). Post-WSSP, teacher confidence in teaching science content improved significantly in all four content strands, but especially the physical science content of the curriculum (*energy and forces* and *materials*). Teachers became much more confident with a number of the more conceptually challenging physical science topics such as those mentioned above.

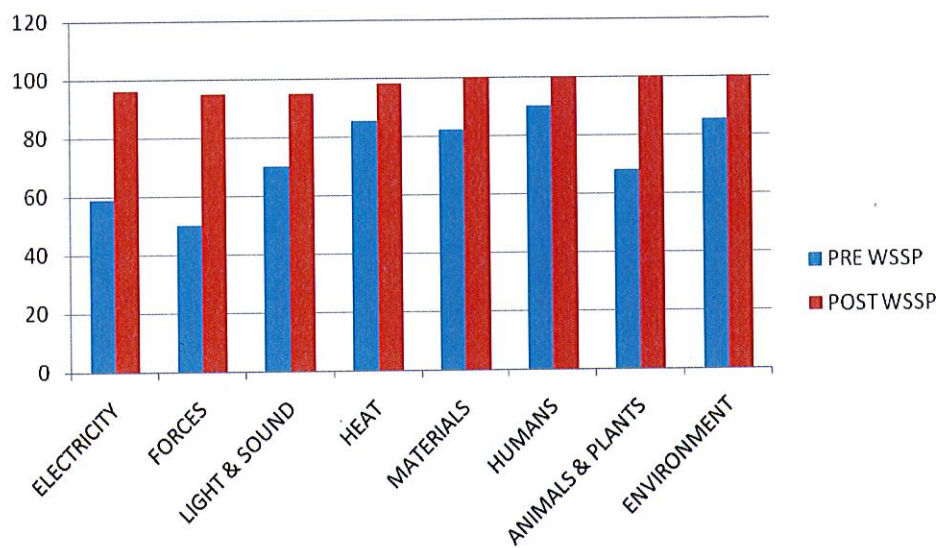
#### *Conceptual Development of teachers*

As well as trying to change teachers attitudes towards school science and teaching science WSSP also set out to develop the conceptual understanding of the participating teachers. A test was administered to the participating teachers pre and post WSSP. Questions on the test were designed specifically to elucidate misconceptions that might be held by teachers; especially in areas of the curriculum that have been shown to cause difficulty for teachers such as, energy and forces. The questions also related to objectives in the different strand units of the Science Curriculum (DES, 1999). The facilitator considered that if teachers are to be competent in teaching these strand units they should have sufficient scientific conceptual understanding.

Figure 4 provides a summary of the percentages of teachers who responded correctly to questions from each curriculum strand at pre and post intervention stages. It shows that prior to WSSP many of the teachers had misconceptions in a number of key areas, especially physical science. These responses point to a lack of knowledge and understanding of basic concepts underpinning science. On a more positive note, it is apparent from examination of the pre and post test scores that there was an increase in teachers' scientific content knowledge, especially in those areas concerned with physical science. According to Harlen (1997) such gains in teachers' understanding of science concepts is fundamental to improving the quality of teaching and learning in science.

It would appear therefore that WSSP has had a major impact on the development of more accurate scientific concepts amongst this cohort of teachers.

**Figure 4: Percentages of teachers responding correctly to questions of basic science concepts (before and after WSSP programme)**



*Impact of the intervention programme on classroom practice.*

All the teachers involved with WSSP stated that their confidence in teaching science improved as a result of their involvement in the project. Teachers identified a number of specific areas where their confidence improved. The areas included: teaching practical science; dealing with and understanding science concepts; using innovative resources and trying different approaches to teaching science. This is a very encouraging finding, as the intervention programme placed a strong emphasis on enhancing both teacher's pedagogical and subject knowledge.

A number of their comments include:

“what we do here in the hands-on work is very simple, I can ask questions on the activities, this gives me more confidence to go back to my children and try it with them”

“when I started the workshops my science knowledge was at a very low ebb, it has really improved and I put this down to the discussions, hands-on and my enjoyment at the workshops”

“the generosity of the Irish American Partnership and the Department means my students can have the same science resources as other children in bigger schools”

Many teachers talked about their dependency on science textbooks and curriculum guidelines prior to their involvement in the project. One teacher stated “since joining the project I have

moved away from the textbook [science] and I have used many of the ideas I have picked up here [workshops]”.

Teachers discussed how the project encouraged them to actively reflect and reformulate their pedagogical thinking. One declared “I think more about what I am teaching and the methodologies I use”

Many teachers talked of successfully using a number of innovative teaching methodologies in science lessons such as: concept cartoons, concept mapping, and Predict-Observe-Explain. One teacher stated “I think concept cartoons are excellent, you can use them in so many ways. They create healthy debate and encourage children to think for themselves”.

### *Impact of WSSP on children*

Teachers were asked whether they had observed any changes in the students’ attitudes toward science since participating in WSSP. They all claimed that the changes were very positive. Results showed that post-intervention the number of children saying that they liked science increased significantly. This is an important finding as international research (Pell & Jarvis 2001) shows that students’ attitudes to school science deteriorates as the students progress through primary school. WSSP therefore has had a hugely important positive effect.

The following comments represent a sample of what teachers said about their students attitudes towards school science “they remind you at the start of the week that you have to do science with them”, “they request it a lot more than they use to” and “they say ‘oh yes’ when you tell them you are doing science with them”. Teachers identified a number of reasons why they thought their students attitudes changed. The reasons included that students engaged in more hands-on activities, and also that teachers themselves were more confident teaching science. One teacher claimed “they enjoy it more because it is a more hands-on subject for them now, whereas before I would ask them to take out their textbook and we would talk about science facts”. Another maintained that “I think my children love science because I am more confident in teaching it now....when you are more confident teaching it reflects on them”.

Overall these teachers’ responses clearly indicated that the approach taken by this professional development project had a significant impact on science instruction in the classrooms of the participants. Teachers talked about doing more hands-on activities and trying different teaching methodologies with their students. The teachers wanted professional development courses that were: on-going; relevant to their needs, and collaborative in nature. Most importantly their experiences with the WSSP model of professional development were very positive. They commented on the on-going nature of the workshops, allowing time for them to try out ideas between sessions. They felt the hands-on nature of the workshops made science relevant to their own classroom experiences and their experiences of sharing ideas

and resources and engaging in open pedagogical discussion increased their confidence and competence in teaching science to their students.

## **Conclusions**

It is just eight years since the introduction of science as a compulsory subject in the revised primary school curriculum. This has been very successful in raising the status of science in our primary schools. However, it also had implications for many teachers who have little or no science knowledge in their education. They had to learn new science knowledge and pick up new pedagogical skills. The results of WSSP indicated that prior to the programme teachers had low confidence levels in their ability to teach primary science effectively to their students. Many of the participants did not understand a number of the science concepts essential to the teaching of primary science. In fact, a number of them had the same misunderstandings of science concepts as their students. The positive impact of WSSP on developing teachers' confidence, understanding of science and skills in teaching science was evident at the end of the programme.

Areas of concern at the start of the programme included;

- confidence among teachers to teach science was lower than all the other curriculum subjects.
- low confidence levels teaching physical science in particular although confidence for biological science was adequate.
- the narrow range of teaching methodologies teachers used when teaching science – many of them did not use methodologies that encouraged their students' to carry out hands-on activities and develop an understanding of the science concepts related to these activities;
- low teacher confidence in developing student scientific and design & make skills;
- low teacher confidence in their own science teaching skills.

Post-intervention there was a significant improvement in all the areas mentioned above.

The WSSP model of continuing professional development has been successful because it allowed work that was on-going. It was hands-on and relevant to teachers needs. The collaborative nature of the programme was successful in developing teachers' confidence and competence in teaching science. The regular input from the workshops and the facilitator enhanced teachers' pedagogical as well as their science knowledge. Teachers' attitudes towards science and understanding of science changed because WSSP encouraged them to experience the same roles that their students would experience. They engaged in hands-on activities and open discussions which helped them construct their understanding of science



concepts and most importantly they carried out activities with students and then discussed their experiences with colleagues in school or at the next workshop.

### *Other Key Developments*

As well as having a positive impact on the teaching and learning of school science, WSSP has provided considerable benefits for teachers and schools in a number of key areas within a relatively short timeframe. Three significant benefits and developments for teachers stand out:

#### *Developing a Collaborative Culture - tackling professional isolation and insulation*

One of the key aims of the project was to break down the insulation and isolation that teachers experience in their day-to-day professional lives. When it comes to teaching and learning many of Ireland's teachers are largely isolated from their professional colleagues. According to an OECD Report (2003), *Isolation: is one of the most stable factors in Irish schools today*. This isolation was a challenge in the early stages of the project. Through developing a culture of meaningful collaboration the project has made encouraging inroads into breaking down professional isolation. Building up trust over time was the key to developing a culture of meaningful collaboration. This involved a number of strategies including: project facilitator working closely with the teachers; involving participants in the decision making process – encouraging them to believe in the relevance and importance of what they are engaged in; and looking at 'real' issues and the needs of teachers in the day to day reality of their classroom as well as subject and pedagogical knowledge. A major benefit of meaningful collaboration was that it enabled teachers themselves to see insulation and isolation as a disabling feature of their professional lives.

#### *The skill of reflection – in a supportive environment*

Collaboration at the workshops, and visits by the co-ordinator to the schools helped to increase teachers' capacity for reflection; they have become more reflective of their pedagogic practice. Teachers are asking questions regarding the learning that takes place in their classroom and the relationship between the teacher and student. Teachers are looking at the student as a learner, and looking at different ways of bringing students more into the centre of the learning process. Many of the participating teachers are carrying out action research in their classrooms and looking at new ways to encourage students to become more active learners.

### *Professional community with other teachers*

In addition to the formal collaborative networks instituted through the projects workshop, the teachers have established their own informal networks. Teachers who previously didn't know each other now contact each other professionally (telephone, e-mail, informal meetings) sharing ideas and tasks exchanged at workshops and also sharing resources. Networks such as these are regarded by teachers as a major benefit of the project and are very important in addressing the problem of isolation.

### *Final observations*

WSSP has shown that in order to make any lasting and noticeable difference to teachers' performance in science lessons, their individual professional development in primary science must take place over a period of time, rather than in the form of one-day workshops. It must involve teachers in active collective participation giving them sustained opportunities to consciously develop, practice, reflect upon and refine their science knowledge and skills. The work of the programme revealed that there are real benefits to be gained from encouraging teachers to get involved in professional development.

Historically, small rural schools are underserved by their isolation and insulation. Of particular benefit to participating teachers has been the breakdown of this isolation and insulation, through the support and collaboration with other teachers both inside and outside their own schools. Continuous professional development for the enhancement of teaching and learning must come to be seen as a normal aspect of all teachers work in the 21<sup>st</sup> century.

It is the belief of everyone that has been involved in WSSP that this type of continuing professional development is a successful model that would provide lasting improvements in the teaching and learning of primary science.

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## Appendix: List of participating schools

### Galway

School	Principal
Milltown N.S. Milltown, Tuam, Co. Galway	Tom Casby
St. Brendan's N.S. Belmont, Milltown, Co. Galway	Eleanor Sheridan
Carnageehy N.S. Ballyglass, Milltown, Co. Galway	Mary Higgins
Sylane N.S., Sylane, Tuam Co. Galway	Sinéad Cleary
Kilconly N.S., Kilconly, Tuam, Co. Galway	Pat McWalter

### Donegal

Scoil Roisin, Dungloe, Co. Donegal	James Gillespie
Meenagowan N.S., Meenagowan, Co. Donegal	Margaret Dillon
SN an Aingil Choimeadai, Keadue, Co. Donegal	Maire Bean Mhic Giolla Choill
Scoil Chroine, Dungloe, Co. Donegal	Seamus O'Branainn (retired)
SN Mhuire, Belcruit, Co. Donegal	Marianne Comack

### Mayo

S.N.Sheamais, Barnacogue, Swinford, Co. Mayo	Mrs Carmel Sherlock
Kinaffe N.S., Swinford, Co. Mayo	Margaret Olivia Noone
St Treasa's NS, Kilkelly Co. Mayo	Richard Phillips
Coogue N.S. Aghamore, Ballyhaunis, Co Mayo.	Ms Siobhan Geraghty
St. Joseph's N.S., Midfield, Swinford, Co Mayo	Tony Fahy

